Service, 300 South Ferry Street, Terminal Island, California, 90731; and

Reginal Director, Northwest Region, National Marine Fisheries Service, 7700 Westlake Avenue North, Seattle, Washington, 98109.

Dated: February 14, 1979.

WILLIAM ARON,
Director, Office of Marine Mammals/Endangered Species National Marine Fisheries Service.

[FR Doc. 79-5382 Filed 2-20-79; 8:45]

[6560-01-M]

ENVIRONMENTAL PROTECTION AGENCY

[FRL 1060-8]

WAIVER APPLICATION BY ATLANTIC RICHFIELD CO.

Decision of the Administrator

I. INTRODUCTION

Section 211(f) of the Clean Air Act (Act), 42 U.S.C. 7545(f) (1977) contains prohibitions and limitations on the use of controlled fuels and fuel additives.[1] Section 211(f)(1) prohibits, after March 31, 1977, any manufacturer from first introducing into commerce or increasing the concentration in use of any controlled fuel or fuel additive. Section 211(f)(3) prohibits any manufacturer which first introduced into commerce or increased the concentration in use of any controlled fuel or fuel additive between January 1, 1974 and March 31, 1977, from distributing such fuel or fuel additive in commerce after September 15, 1978.

Waivers may be obtained for any of the section 211(f) prohibitions or limitations. Section 211(f)(4) provides that the Administrator of the Environmental Protection Agency (EPA), upon application of any manufacturer of a fuel or fuel additive, may grant a waiver if he determines that the applicant has established that the fuel or fuel additive or a specified concentration thereof, and the emission products of such fuel or additive or specified concentration thereof, will not cause or contribute to the failure of any emission control device or system (over the useful life of any vehicle in which such device or system is used) to achieve compliance by the vehicle with the emission standards with respect to which it has been certified pursuant to section 206 of the Act. If the Administrator does not act to grant or deny an application within 180 days of its receipt, the waiver is granted by operation of the Act.

I have received an application for a section 211(f)(4) waiver for Arconol.[2] The application for Arconol, for a concentration range of 0 to 7 volume percent, was received on August 11, 1978, from Atlantic Richfield Company (ARCO). ARCO concluded from the data it submitted that unleaded gasoline containing up to 7 volume percent of Arconol and its emission products do not cause or contribute to the failure of any emission control device or system (over the useful life of any vehicle in which such device or system is used) to achieve compliance by the vehicle with the emission standards with respect to which it has been certified pursuant to section 206 of the Act. The 180 day review period for the ARCO application expires February 7, 1979.

Although not required, a public hearing[3] on this application was held on September 6, 1978, in Washington, D.C., and the thirty day comment period following the hearing ended on October 6, 1978.

II. SUMMARY OF THE DECISION

I have determined that ARCO has met the burden under section 211(f)(4) necessary to obtain a waiver for Arconol in the concentration range of 0 to 7 volume percent.[4]

ARCO and other interested parties have submitted data on Arconol primarily at a concentration of 7 volume percent. I find that the data presented on Arconol are sufficient to establish that Arconol in a concentration range of 0 to 7 volume percent and the emission products of Arconol when used in this concentration range will not cause or contribute to the failure of any emission control device or system (over the useful life of any vehicle in which such device or system is used) to achieve compliance by the vehicle with the emission standards with respect to which it has been certified pursuant to section 206 of the Act.

I, therefore, grant the waiver request for use of Arconol in unleaded gasoline in the concentration range of 0 to 7 volume percent provided the volatility properties of the unleaded gasoline containing Arconol are within the limits of the American Society for Testing and Materials (ASTM) unleaded gasoline specifications.[5]

III. METHOD OF REVIEW

In order to obtain a waiver for Arconol in a concentration range of 0 to 7 volume percent, the applicant must establish that Arconol in that concentration range and the emission products of Arconol when used in this concentration range will not cause or contribute to the failure of any emission control device or system (over the useful life of any vehicle in which such system or device is used) to achieve compliance by the vehicle with the emission standards with respect to which it has been certified pursuant to section 206 of the Act. This burden, which Congress has imposed upon the applicant, if interpreted literally, is virtually impossible to meet as it requires the proof of a negative proposition, i.e., that no vehicle will fail to meet emission standards with respect to which it has been certified. Taken literally, it would require the testing of every vehicle. Recognizing that Congress contemplated a workable waiver provision some mitigation of this stringent burden was deemed necessary. For purposes of the waiver provision, it is recognized that reliable statistical sampling and fleet testing protocols could safely be used to demonstrate that a fuel or fuel additive under consideration would not cause or contribute to failure of emission standards by automobiles in the national fleet.

Data submitted with respect to a waiver request are analyzed by appropriate statistical methods in order to characterize the effect that a fuel or fuel additive will have on emissions. The statistical tests applied to the emission data provided in support of this Arconol waiver request are: a Paired Difference Test, Sign of Difference Test, and a test which compares the deteriorated emissions with the emissions standards (hereafter, Deteriorated Emissions Test).

The following is a brief description of the statistical tests utilized to characterize the emissions effect of Arconol.[6]

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[1] Section 211(f) makes it unlawful upon March 31, 1977 "for any manufacturer of any fuel or fuel additive to first introduce into commerce, or to increase the concentration in use of, any fuel or fuel additive for general use in light duty motor vehicles manufactured after model year 1974 which is not substantially similar to any fuel or fuel additive utilized in the certification of any model year 1975, or subsequent model year, vehicle or engine under section 206 [of the Act]."

[2] Arconol is the trade name for a fuel additive which consists primarily of tertiary butyl alcohol (TBA). This decision is applicable to TBA.

[3] See, "Gasohol and MTBE Waiver Request: Public Hearing," 43 Fed. Reg. 36,686 (1978). The public record (record No. MSED-211(f)-TBA) is available for public inspection in the Public Information Reference Unit, Environmental Protection Agency, Room 2922, 401 M Street, S.W., Washington, D.C. 20460. This record contains all the information considered in this decision.

[4] In determining whether an applicant has met his burden, the Administrator may look at all of the available data including data provided by parties other than the applicant.

[5] Standard Specification for Automotive Gasoline, Annual Book of ASTM Standards—1978, Part 23, D 439-78, p. 225.

[6] A more detailed description of these tests and their background may be found in the "Characterization Report-Analysis of Fuel

Footnotes continued on next page

(1) THE PAIRED DIFFERENCE TEST

For each vehicle tested on a base gasoline and an Arconol containing fuel, the difference between the Arconol fuel emissions and the base fuel emissions was calculated. A 90% confidence interval was constructed for each of these differences. If the resulting interval lies entirely below zero it is indicative of no adverse effect from Arconol; if the entire interval is above zero, it is indicative of an advere effect from Arconol. If the interval contains zero, there is arguably no difference between the base fuel and the Arconol containing fuel with regard to emissions provided the confidence interval is small.

(2) THE SIGN OF DIFFERENCE TEST

For each vehicle tested with a base gasoline and an Arconol containing fuel, the sign of the emission difference between Arconol fuel emissions and base fuel emissions was ascertained. This test is designed to determine whether the number of vehicles demonstrating an increase (+) in emissions with Arconol significantly (at a 90% confidence level) exceeded those showing a decrease (−) in emissions with Arconol.

(3) THE DETERIORATED EMISSIONS TEST

For each vehicle, the effect Arconol had on emissions was determined. This incremental effect, either positive or negative, was added to the 50,000 mile certification emission value for the certification emission vehicle which the test vehicle represented. This incremented 50,000 mile emission value was compared to emissions standards to determine if it did or did not exceed the standards. Either a pass or fail was assigned accordingly. The pass/fail results were analyzed using a one-sided sign test.[7]

The first two methods of analysis are designed to determine whether the fuel or fuel additive has an adverse effect on emissions as compared to the base fuel. Each characterizes a different aspect of adverse effect. The paired difference test determines the mean difference in emissions between the base fuel and the additive containing fuel. The sign of difference test assesses the number of vehicles indicating an increase or decrease in emissions. The two tests are considered together in evaluating whether an adverse effect exists to assure that a mean difference determination is not unduly influenced by very high or very low emission results from only a few vehicles.

The Deteriorated Emissions analysis indicates whether the fuel or fuel additive causes a vehicle to fail to meet emission standards. This test examines each vehicle's emission performance as compared to each pollutant standard. It is useful to perform this analysis even if the first two analyses indicate the fuel or fuel additive has no adverse effect. The analysis will indicate whether the emissions from any particular types of vehicles or special emission control technologies are uniquely sensitive to the fuel or fuel additive thus causing failures. This effect could be masked in the previous analyses which consider the emissions results as a group without distinguishing the emissions impact on subgroups.

An alternative to providing the amount of data necessary to meet the statistical requirements is to make judgments based upon a reasonable theory regarding emissions effect supported by confirmatory testing. If there exists a reasonable theory which predicts the emission effect of a fuel or fuel additive, an applicant only needs to conduct a sufficient amount of testing to demonstrate the validity of such theory. This theory and confirmatory testing then form the basis from which the Administrator may exercise his judgment on whether the fuel or fuel additive will cause or contribute to the failure of any emission control device or system to achieve compliance by the vehicle with emissions standards.

IV. NATURE OF THE TEST DATA

The varying nature of fuels or fuel additives may alter the type and amount of testing required to determine whether such fuels or fuel additives cause or contribute to the failure of vehicles to comply with emission standards. A fuel or fuel additive which is expected to affect the performance of emission control devices or systems adversely over a period of time and mileage may require 50,000 mile durability testing to determine whether such effects exist.

On the other hand, a fuel or fuel additive which is expected to have only an instantaneous emission effect on a vehicle could be judged by comparing back-to-back emission tests on the same vehicle.[8]

It is possible that a fuel or fuel additive may operate to cause both an instantaneous increase and an increased deterioration of emission control systems or devices. If so, then both durability emission data and instantaneous emissions data may be required.

Upon examination of the available data on material compatibility and the chemistry of Arconol, EPA has concluded that 50,000 mile durability testing data are not essential to this waiver decision.[9] A reasonable estimate of a test vehicle's emissions performance on Arconol can be obtained using back-to-back emission test data in lieu of requiring 50,000 mile durability testing.

V. ANALYSIS

A. EXHAUST EMISSIONS

Exhaust emission data were submitted on 33 vehicles[10] tested on a base fuel and a fuel containing primarily 7% Arconol. When vehicles tested on the base fuel meet standards and fail to meet standards when tested on the Arconol containing fuel, Arconol is deemed to cause the failure of vehicles to meet standards. When vehicles fail to meet standards on the base fuel and the Arconol containing fuel, and the Arconol containing fuel is shown to have an adverse effect on emissions as compared to the base fuel, Arconol is deemed to contribute to the failue of vehicles to meet standards.

Summarized below are the results of three statistical tests. Tests 1 and 2 are designed to determine whether Arconol has an adverse effect on emissions. Test 3 is designed to determine whether Arconol causes vehicles to fail to meet standards.

(1) The Paired Difference Test

Listed below are the 90% confidence intervals around the mean difference between the base fuel and the Arconol containing fuel emission level.

a. HC −0.19 to −0.03
b. CO −3.06 to −1.10
c. NOx −0.11 to 0.03

(2) The Sign of Difference Test

Confidence that an Arconol containing fuel will cause an increase in emissions over the base fuel based on the observed increases out of the total vehicles tested (in parentheses) are stated below.

Footnotes continued from last page
Containing Tertiary Butyl Alcohol (TBA) to Characterize the Impact of 0% to 7% Concentration of TBA on Emissions Performance" (hereafter Characterization Report) at 4.

[7] For purposes of analysis, this test was designed such that the risk of being denied a waiver would be at least 90% if 25% or more of the represented fleet fails to meet emission standards. This approach is related to the approach applied to the vehicle manufacturers under the vehicle assembly line selective enforcement audit procedures. While a more conservative 20% noncompliance rate has been used in some past characterization analyses, 25% is more consistent with the selective enforcement audit procedures.

[8] Back-to-back testing involves measuring, sequentially, the emissions from a particular vehicle, first operated on a base fuel not containing the waiver request fuel additive and then on a base fuel containing the additive or a representative base fuel.

[9] This conclusion is reached from an examination of the available material compatibility information, see, section V(C)(1), infra, and the judgment that the emissions effect of Arconol is of an instantaneous, not a deteriorative nature.

[10] See, the Characterization Report in Table 1 for a description of the vehicles utilized in the test programs.

a. HC (12/33) 5.24% confidence of an increase

b. CO (7/33) 0.03% confidence of an increase

c. NOx (19/33) 73.92% confidence of an increase

(3) Deteriorated Emissions Test

Listed below are the number of vehicles whose incremental 50,000 mile emission values exceeded emission standards.

a. HC 2 out of 32 [11]

b. CO none out of 32

c. NOx none out of 32

The results of tests one and two indicate that for HC and CO, there is high confidence that an Arconol containing fuel causes a decrease in HC and CO emissions. The results for NOx indicate that there is a probability of an increase in NOx emission, but any such increase is very small in magnitude since the 90% confidence interval of the mean difference lies between −0.11 and 0.03. (This interval contains zero and is considered small.) This indicates that Arconol does not have an adverse effect on emissions of the vehicles as a group to meet emission standards without applying a deterioration factor.

The results of the third test indicate that the Arconol containing fuel caused two vehicles in the test fleet to exceed emission standards when emissions deterioration for 50,000 miles was included in the analysis. However, the two vehicles which failed are California three-way Catalyst vehicles designed to meet the California nonmethane hydrocarbon standard. The failures result when the deteriorated emissions from these vehicles are compared to the more stringent future federal hydrocarbon standards (which include methane). While the California techology is the best surrogate currently available of the future federal fleet, such vehicles are designed to meet a less stringent standard which limits the conclusiveness of failures shown by direct comparision to such federal standards. Because tests 1 and 2 show no adverse effect on emissions as a group and test 3 shows that only 2 out of 32 vehicles are caused to exceed standards (5 vehicle failures out of 32 vehicles would be required to fail this test), we conclude, taking into consideration the nature of the failures, that Arconol does not cause or contribute to the failure to meet exhaust emission standards.

B. EVAPORATIVE EMISSIONS

ARCO theorized that evaporative emissions are directly related to volatility characteristics and that fuels blended with Arconol have final volatility characteristics similar to present commercially available gasoline. [12]

ARCO performed a test program to confirm this theory. It tested seven fuels with volatility properties within the ASTM unleaded gasoline specifications. The fuels, including two fuels blended with 7% Arconol, were chosen to provide a range of volatility. The test program demonstrated [13] that when the volatility properties of the gasoline containing Arconol are within the ASTM specifications, its evaporative emission performance is no worse than the evaporative emissions of the commercially available fuels of similar volatility. The volatility of commercially available gasoline varies over a substantial range.

It would be discriminatory to require an applicant's fuel or fuel additive to meet a more stringent volatility limit in order to control evaporative HC emissions than is characteristic of commercially available fuels. Thus, Arconol will not be considered to cause or contribute to the failure of emission control devices or system (over the useful life of any vehicle in which such device or system is used) to achieve compliance by the vehicle with the evaporative emission standard if its volatility is within the ASTM specifications for automotive gasoline. If the volatility of gasoline were to eventually be regulated, then Arconol or any other fuel or fuel additive would have to comply with the regulatory requirements.

Consequently, unleaded fuel containing Arconol with volatility properties within ASTM gasoline specifications will not cause or contribute to the failure of any emission control device or system (over the useful life of any vehicle on which such device or system is used) to achieve compliance by the vehicle with the emission standards with respect to which it has been certified pursuant to Section 206.

C. TECHNICAL ISSUES

1. Materials Compatibility

The issue of Arconol's compatibility with components of the vehicle's fuel system was raised by General Motors (GM) and Ford.[14] Data submitted by ARCO and Suntech, Inc.[15] indicate that Arconol does not pose a materials compatibility problem. Additionally, the present use of Arconol in fuel up to 5% has apparently not caused any noticeable problems.[16] Therefore, I conclude based on prior experience, these data, the chemistry of Arconol, and our judgment, that Arconol does not present a materials compatibility problem.[17]

2. Driveability

The issue of driveability was raised by GM and Ford.[18] Poor driveability caused by a fuel or fuel additive could impact emissions either through engine malfunction or misadjustment of engine components in an effort to improve driveability. Significant driveability problems solely attributable to a fuel additive should not occur if the fuels are manufactured to meet marketing standards. In fact, Ford in its submission concluded that potential driveability problems could be eliminated by "proper blending" of the fuel.[19] This is apparently true since ARCO has been using Arconol at 5% since 1970 and 7% since 1974. I, therefore, conclude that driveability is not a significant problem with regard to emissions.

VI. FINDINGS AND CONCLUSIONS

I have determined that ARCO has established that Arconol, in a concentration range of 0 to 7 volume percent, and the emission product thereof will not cause or contribute to a failure of any emission control device or system (over the useful life of any vehicle in which such device or system is used) to achieve compliance by the vehicle with the emission standards with respect to which it has been certified pursuant to section 206 of the Clean Air Act.

The Atlantic Richfield Company's request for a waiver of the section 211(f) prohibitions and limitations for the use of Arconol is hereby granted. This waiver is for the use of Arconol in unleaded gasoline provided that the volatility of the resulting fuel meets ASTM unleaded gasoline specifications.

[11] One of the 33 vehicles in the data base is a developmental vehicle. Since such a vehicle cannot have a certification emission value, the third test cannot be applied.

[12] Fuel volatility is described by a combination of its partial pressure at 100° F (Reid vapor pressure) and its distillation properties (ASTM D-86).

[13] *See*, Analysis of Evaporative Data in the Characterization Report at 12.

[14] *See*, General Motors' (GM) submission, MSED-211(f)-TBA-6, and Ford's submission MSED-211(f)-TBA-9.

[15] *See*, Suntech's submission MSED-211(f)-MTBE-30 at Section III.

[16] ARCO has been using up to 5% Arconol since 1970 and up to 7% since 1974 without apparent material compatibility problems. Therefore, the vehicle manufacturers should have already accommodated for Arconol in their design.

[17] *See*, Emission and Compatibility Effects of Gasohol, MTBE, and TBA. MSED-211(f)-TBA-25.

[18] *See*, GM's submission MSED-211(f)-TBA-6 and Ford's submission MSED-211(f)-TBA-9.

[19] *See*, Ford's submission MSED-211(f)-TBA-9.

Dated: February 6, 1979.

DOUGLAS M. COSTLE,
Administrator.

CHARACTERIZATION REPORT

ANALYSIS OF FUEL CONTAINING TERTIARY BUTYL ALCOHOL (TBA) TO CHARACTERIZE THE IMPACT OF 0 PERCENT TO 7 PERCENT CONCENTRATION OF TBA ON EMISSIONS PERFORMANCE

February 1979

Technical Support Branch, Mobile Source Enforcement Division, Office of Mobile Source and Noise Enforcement, U.S Environmental Protection Agency.

Summary

This paper presents a characterization analysis of the emission data presented in support of the request from the Atlantic Richfield Corporation for a waiver of the limitation and prohibition from use of Arconol [primarily tertiary-butyl alcohol (TBA)] in a 0-7% concentration in unleaded fuel. Included are a description of the sources of test data, the statistical analysis of the data, and a discussion of the conclusions drawn.

Tailpipe emissions data are analyzed by three methods to statistically characterize the emissions performance of 7% TBA containing fuels. Evaporative emissions are analyzed by regression analysis to confirm a technical theory that evaporative emissions are directly related to fuel volatility.

Sources of Data

EPA has received back-to-back FTP exhaust emissions data* on twenty-eight oxidation catalyst vehicles and five three-way catalyst vehicles from the following sources: Atlantic Richfield Company (ARCO), the Ford Motor Company, Texaco Incorporated, and Mobil Oil Company. A description of the vehicles tested in each program is contained in Table 1.

Atlantic Richfield, in support of its waiver request for the use of up to 7% TBA has submitted back-to-back FTP data on sixteen 1977 or later model vehicles. Of these, thirteen vehicles were equipped with oxidation catalysts and three were equipped with three-way catalysts. The base fuel for ten of the oxidation catalyst and all of the three-way catalyst vehicles was an ARCO unleaded fuel. These vehicles were tested on the base fuel and a fuel blended with 7% TBA having characteristics similar to the base fuel. The remaining three vehicles were tested on a blended low volatility fuel, a blended low volatility fuel containing 7% TBA, a high volatility fuel, and a blended high volatility fuel containing 7% TBA. SHED (Sealed Housing for Evaporative Emissions) tests were run only on these last three vehicles.

Texaco submitted data on eight 1978 and 1979 oxidation catalyst vehicles comparing FTP emissions on an unleaded Texaco base fuel versus a fuel blended with 7% TBA having characteristics similar to the base fuel.

Ford Motor Company tested seven 1978 or later vehicles on indolene and indolene mixed with 7% TBA. Two test vehicles were equipped with three-way catalysts; one of these was a developmental vehicle, and one was a production vehicle. The five remaining production vehicles were equipped with oxidation catalysts.

Mobil Oil Corporation submitted FTP and SHED emissions test data on one 1978 and one 1979 vehicle. Both cars were equipped with oxidation catalysts. Each car was tested on a different base fuel and a fuel blended with 7% TBA having characteristics similar to the base fuel.

Analytic Procedures

This section reviews several procedures designed to examine the effects of 7% TBA* containing fuels compared to base fuels. They are:

(1) Paired difference test

(2) Sign of difference test

(3) Comparison of deteriorated emissions with standards

Each test was applied to data for a specific catalyst technology type and data source. Sample sizes, means, variances, standard deviations and a fuel code reference are listed for each vehicle in Appendix 1.

(1) Paired difference test

For each vehicle tested on a base fuel and a 7% TBA containing fuel (hereafter TBA fuel), the differences between the TBA fuel emissions and the base fuel emissions were calculated. A 90% confidence interval was constructed for each of these differences.

This method of establishing 90% confidence intervals on the mean difference implicitly assumes emissions follow a normal distribution. While this requirement may not be exactly met the method is robust enough to withstand some deviation from the normality assumption. This interval can be interpreted as: In approximately 90 experiments out of 100, one is confident that the interval so constructed would include the true value of the mean emission difference (i.e., TBA fuel effect). If the resulting entire interval is below zero it is indicative of a decrease in emissions from TBA; if the entire interval is above zero, it is indicative of an increase in emissions from TBA.

If the interval contains zero, there is arguably no difference between the base fuel and TBA fuel emission levels provided this interval is reasonably small. Since the length of the confidence interval can be large in the case of a small sample size, any interval containing zero must be sufficiently small that its upper limit does not exceed 10% of the applicable emission standard to reasonably contend that no increase in emissions has occurred.

In order to assure that intervals covering zero are small enough, sufficient samples must be taken. Since the interval length varies inversely with the sample size, an increase in sample size would decrease the interval length. If the interval length were sufficiently small, one of three possible results could occur:

(i) the entire interval would lie below zero;

(ii) the interval would include zero and the upper limit would be lower than 10% of the applicable emission standard; or

(iii) the entire interval would lie above zero. In general, the result is dependent on the location of the sample mean. Any of the three results would permit a definitive conclusion to be drawn. Hereafter, the situation in which a confidence interval includes zero, but has an upper limit above 10% of the standard will be referred to as having "insufficient data to reach a definitive conclusion".

Therefore, this procedure considers an increase in emissions from TBA to exist when this confidence interval lies entirely above zero. A lack of an increase in emissions is said to exist if the confidence interval is entirely below zero or if it contains zero while the upper limit does not exceed 10% of the applicable standard.

For the purposes of this procedure, replicate tests on any one vehicle and fuel were averaged to provide a single data point in the analyses. Each vehicle carried an equal weight in the determination of the confidence interval.

The results of this procedure are shown in Table 2. Where a dash appears, there was insufficient data (either no observations or only one observation) to construct an interval.

For oxidation catalysts, the results are summarized by:

(a) Mobil Unleaded with 7% TBA—Insufficient data to construct any interval.

(b) ARCO Unleaded with 7% TBA—HC and CO emissions decrease; NO_x emissions did not increase.

*Back-to-back FTP testing involves measuring, sequentially, the emissions from a particular vehicle, first operated on a base fuel not containing the waiver request fuel or fuel additive and then on the base fuel containing the additive.

*The one ARCO vehicle tested on 5% Arconol is not subject to those statistical tests because such tests cannot be performed on a single data point. However, the emission results of this vehicle are consistent with the 7% data and are presented in the Appendix 1 data listing.

(c) ARCO Low Volatility with 7% TBA—insufficient data to reach a definitive conclusion.

(d) Texaco Unleaded with 7% TBA—HC emissions decreased; CO emissions did not increase; NO_x emissions decreased.

(e) Indolene with 7% TBA—HC emissions did not increase; CO emissions decreased; NO_x emissions increased.

(f) All sources with 7% TBA—HC and CO emissions decreased; NO_x emissions did not increase.

For three-way catalysts, the results are summarized by:

(a) Mobil Unleaded with 7% TBA—no data.

(b) ARCO Unleaded with 7% TBA—HC, CO, and NO_x emissions did not increase.

(c) ARCO Low Volatility with 7% TBA—no data.

(d) Texaco Unleaded with 7% TBA—no data.

(e) Indolene with 7% TBA—insufficient data to reach a definitive conclusion for HC and CO emissions; NO_x emissions did not increase.

(f) All sources with 7% TBA—HC, CO and NO_x emissions did not increase.

For a combination of technologies (oxidation and three-way catalysts), the results are summarized by:

(a) Mobil Unleaded with 7% TBA—insufficient data to construct any interval.

(b) ARCO Unleaded with 7% TBA—HC and CO emissions decreased; NO_x emissions did not increase.

(c) ARCO Low Volatility with 7% TBA—insufficient data to reach a definitive conclusion.

(d) Texaco Unleaded with 7% TBA—HC emissions decreased; CO emissions did not increase; NO_x emissions decreased.

(e) Indolene with 7% TBA—HC and CO emissions did not increase; NO_x emissions increased.

(f) All sources with 7% TBA—HC and CO emissions decreased; NO_x emissions did not increase.

Thus, for this sample, combining all sources resulted in reduced HC and CO emissions and no increase in NO_x emissions for oxidation catalyst vehicles. A conclusion of no increase in emissions can be drawn for three-way catalyst vehicles using 7% TBA fuel. A combination of all sources with both oxidation and three-way catalysts, showed reduced HC and CO emissions with a conclusion of no NO_x emission increases.

(2) *Sign of difference tests*

For each vehicle tested with a base fuel and a TBA fuel, the sign of the emission difference between TBA fuel emissions and base fule emissions was ascertained. The sign or these differences was considered. This non-parametric test was designed to determine whether the number of cars demonstrating an increase (+) in emissions with TBA fuel significantly (at a 90% confidence level) exceeded those showing a decrease (−) in emissions with TBA fuel.

In each test for each pollutant, the null hypothesis was that the median emission level for that pollutant was the same for both the base and the TBA fuel. The alternative hypothesis for HC, CO, and NO_x was that the median emissions level for TBA fuel was higher than that of the base fuel.

The number of vehicles for which an increase in emissions was observed was calculated for each fuel and technology combination. If there were no real differences in emission levels attributable to TBA fuel, the expected proportion of instances in which an increase between fuels would occur for any pollutant would be .5. Thus a large proporation of observed increases in emission levels for a pollutant would indicate an increase in emissions from TBA fuel. Similarly, a small proportion of increases in emission levels would indicate a positive effect of TBA fuel.

To be able to recognize large and small proportion increases (compared with .5) with confidence a sufficient sample size is required.

Table 3 shows the results of this procedure. In the case of NO_x for oxidation catalysts, the sample sizes that were sufficient indicated an increase in the emission levels for this pollutant with high confidence for the ARCO Unleaded vehicles when TBA was blended in the fuel. The overall case (all fuels, all vehicles—oxidation catalysts only) indicated an increase in NO_x emission levels with a 57.18% confidence with TBA added to the fuel. A combination of technology classes and vehicles resulted in a 73.92% confidence of an increase in NO_x emission levels when TBA was blended with the fuel. HC and CO emission levels did not indicate an increase in these pollutants for either oxidation catalysts, three-way catalysts, or the combination of both catalysts.

(3) *Comparison of deteriorated emissions with standards*

In order to determine whether TBA would cause the failure of any vehicle to meet emission standards during its useful life, a one-sided sign test to evaluate compliance using projected 50,000 mile emission levels was performed. This statistical procedure assumes that the difference in emission levels between the base fuel and TBA fuel for a particular vehicle either remains constant or becomes larger over the useful life of the vehicles.

Projected 50,000 mile emission levels for each nondevelopmental test vehicle (on which EPA had received sufficient vehicle identification information) were obtained by using average Federal Test Procedure (FTP) results and 50,000 mile certification data.

The test was designed such that the risk of failing would be at least 90% if 25% or more of the represented fleet failed to meet Federal emission standards for the particular TBA blend considered.*

The risk of failing this procedure is high for small sample sizes but decreases when the sample size is encreased. Under this procedure, the critical number (the smallest number of projected test failures for a given sample size which would constitute a failure of the criterion) for a sample size of 10 would be one. A sample of less than 10 would be insufficient information to apply the procedure.

Thus for samples of size 10, if one vehicle failed to meet emissions standards with its projected 50,000 mile value, the review criterion was a failure.

This procedure was evaluated for each fuel and technology combination. It was applied as follows: For each nondevelopmental vehicle for which there existed sufficient vehicle information, the 50,000 mile emissions levels were obtained from the certification test results for its configuration. The difference between average emissions levels for the TBA fuel and base fuel were added to these levels to obtain projected 50,000 mile levels. These projected levels were then compared to emissions standards to which the vehicle was certified. A failure was recorded when a projected level exceeded the appropriate standard. Table 4 displays the results of this procedure.

The number of vehicles tested by any single source in a technology class was not sufficient to apply this test to the data. All manufacturer/technology classes using TBA fuel were combined and the base fuels were treated as being essentially the same. That category had 28 vehicles equipped with oxidation catalysts and 4 vehicles with three-way catalysts. Only two three-way catalyst vehicles failed to meet standards. Thus, the oxidation catalyst and the aggregated sample satisfy the criterion.

Evaporative Emissions

Evaporative emission data on three vehicles tested on several fuels having a range of volatility meeting ASTM-D 439 were provided by ARCO. The two Mobil vehicles were also tested for evaporative emissions on fuels of different volatility meeting ASTM-D 439 requirements.

In theory, evaporative losses from the vehicles are directly related to fuel

*The power curves and table of critical values for this test are shown in Appendix 2.

volatility.[1] This relationship has been demonstrated in testing.[2] Therefore, linear regression of evaporative losses versus volatility for all fuels (including TBA fuels) are performed to determine whether the TBA fuel fits that theory. To the extent that correlation is shown, it is expected that the 7% TBA containing fuels will have evaporative emission performance within the range of evaporative emission performance of commercially available fuels.

Figure 1 shows the results of this procedure. The relationship shown between evaporative losses and volatility is positive, and agrees with the technical theory. Further, the evaporative losses on the 7% TBA containing fuel are generally less than those of the high volatility commercial fuel and are below standards.

Conclusions

From the sign of difference test analysis, there is a probability (with 73.92% confidence) of an increase in NO_x emissions with TBA fuel for all vehicles and there is virtually no confidence of any HC or CO increases. The paired difference test shows NO_x emissions increases are very small in magnitude while HC and CO emissions decrease. Thus, use of TBA in a concentration of 7% appears to have no significant adverse effect on HC, CO, and NO_x emissions in both oxidation and three-way catalyst vehicles.

The third procedure, comparing deteriorated emissions with the standards, demonstrates that TBA fuels cause two three-way catalyst* vehicles in the test sample to exceed applicable emission standards. Further, the regression analysis performed to assess the evaporative emission performance comports with the theory that increasing volatility leads to increasing evaporative losses. The TBA fuels had similiar volatility characteristics and evaporative emission as the other fuels meeting ASTM D-439 tested in this program. In addition, vehicle evaporative emissions on both the base fuels and the TBA fuels were below the evaporative emission standard.

[1] Patterson, D.J., *Emissions From Combustion Engines and Their Control*, 1972, pg. 60.

[2] Hurn, R.W., *Effect of Fuel Front-End and Mid-range Volatility on Automobile Emissions*. RI7707

* However, the two vehicles which failed are California three-way catalyst vehicles designed to meet the California non-methane hydrocarbon standard. The failures resulted when the deteriorated emissions from the vehicles were compared to the more stringent future federal hydrocarbon standard, which includes methane. While the California technology is the best surrogate currently available of the future federal fleet, these vehicles were not designed to meet such a stringent standard, which limits the conclusiveness of failures shown by direct comparision to future standards.

TABLE 1.—*Test Vehicle Description*

Source	Model year	Make/model	California/Federal configuration	Catalyst
ARCO	1977	Volvo 244 DL	California	Three-way
ARCO	1977	Ford Mustang	California	Oxidation
ARCO	1977	Ford Pinto	California	Oxidation
ARCO	1978	Chevrolet Impala	Federal	Oxidation
ARCO	1978	Ford Pinto	California	Three-way
ARCO	1978	Pontiac Sunbird	California	Three-way
Ford	1978	Ford Fiesta	California	Oxidation
ARCO	1978	Buick Lesabre	Federal	Oxidation
Ford	1978	Ford Bobcat	California	Three-way
Ford	1978	Ford Fairmont	Federal	Oxidation
Ford	1978	Ford Granada	California	Oxidation
Ford	1978	Ford Developmental	Developmental	Three-way
Ford	1978	Ford Fairmont	Federal	Oxidation
Ford	1978	Ford Light Duty Truck	Federal	Oxidation
ARCO	1978	Buick Skylark	Federal	Oxidation
ARCO	1978	Chevrolet Malibu	Federal	Oxidation
ARCO	1978	Chevrolet Malibu	Federal	Oxidation
ARCO	1977	Mercury Marquis	Federal	Oxidation
ARCO	1979	Mercury Cougar	Federal	Oxidation
ARCO	1977	Pontiac Grand Safari SW.	Federal	Oxidation
ARCO	1978	Olds Cutlass	Federal	Oxidation
ARCO	1979	Ford Futura	Federal	Oxidation
ARCO	1978	Ford Fairmont	Federal	Oxidation
Texaco	1979	Oldsmobile Cutlass	Federal	Oxidation
Texaco	1979	Pontiac Firebird	Federal	Oxidation
Texaco	1978	Buick LeSabre	Federal	Oxidation
Texaco	1979	Mercury Zepher	Federal	Oxidation
Texaco	1978	Ford Fairmont	Federal	Oxidation
Texaco	1978	Mercury Zepher	Federal	Oxidation
Texaco	1978	Chevrolet Impala	Federal	Oxidation
Texaco	1979	Ford Thunderbird	Federal	Oxidation
Mobil	1979	Ford Fairmont	Federal	Oxidation
Mobil	1978	Chevrolet Impala	Federal	Oxidation

TABLE 2.—*90% Confidence Interval for Mean Emission Differences*

	Sample size	HC (grams/mile)	CO (grams/mile)	NO_x (grams/mile)	EVAP (grams/mile)
Oxidation Catalyst:					
(a) Mobil Unleaded (fuel 'A') + 7% TBA	1				
(a) Mobil Unleaded (fuel 'B') + 7% TBA	1				
(b) ARCO Unleaded + 7% TBA	10	[1](−0.49, −0.03)	(−0.46, −0.90)	(−0.17, 0.16)	
(c) ARCO Low Volatility + 7% TBA	3	[2](−0.36, 0.21)	[2](−12.06, 3.67)	[2](−0.58, 0.31)	
(d) Texaco Unleaded + 7% TBA	8	(−0.16, −0.12)	(−1.35, 0.20)	(−0.35, −0.08)	
(e) Ford—Indolene + 7% TBA	5	(−0.21, 0.02)	(−3.61, −0.13)	(0.09, 0.19)	
(f) All Sources—Base + 7% TBA	28	(−0.23, −0.05)	(−3.53, −1.28)	(−.13, 0.03)	
Three-Way Catalyst:					
(a), (c), (d)	No data				
(b) ARCO Unleaded + 7% TBA	3	(−0.08, 0.07)	(−2.64, 0.48)	(−0.03, 0.15)	
(e) Ford—Indolene + 7% TBA	2	[2](−0.26, 0.52)	[2](−3.82, 5.70)	(−0.03, 0.05)	
(f) All Sources—Base + 7% TBA	5	(−0.04, 0.14)	(−1.60, 1.06)	(0.00, 0.09)	
Oxidation and Three-Way Combination:					
(a), (c), (d)	13	(Same as Oxidation Catalyst)			
(b) ARCO Unleaded + 7% TBA	13	(−0.38, −0.02)	(−5.22, −0.94)	(−0.12, 0.13)	
(e) Ford—Indolene + 7% TBA	7	(−0.15, 0.08)	(−2.59, 0.45)	(0.04, 0.16)	
(f) All Sources—Base + 7% TBA	33	(−0.19, −0.03)	−3.06, −1.10)	(−0.11, 0.03)	

[1] For each, the first number represents the lower bound of the 90% confidence interval and the second number represents the upper bound of the 90% confidence interval.

[2] Insufficient data to reach a definitive conclusion.

TABLE 3.—*Sign Test Statistics and Confidence Levels for Comparison of Median Emission Levels Between Base Fuel and 7% TBA Concentrations*

	HC	CO	NOx	EVAP
Oxidation Catalysts—Vehicle Source:				
ARCO Unleaded Increases/Observations	3/10	3/10	7/10	
Confidence Level for Increase (%)	5.47	5.47	82.81	
ARCO Low Volatility Increases/Observations	1/3	0/3	2/3	1/3
Confidence Level for Increase (%)	12.50	0	50.00	12.50
Texaco Unleaded Increases/Observations	4/8	2/8	0/8	
Confidence Level for Increase (%)	36.33	3.52	0	
Mobil Unleaded ('A') Increases/Observations	0/1	0/1	1/1	1/1
Confidence Level for Increase (%)	----------	----------	----------	
Mobil Unleaded ('B') Increases/Observations	0/1	0/1	0/1	1/1
Confidence Level for Increase (%)	----------	----------	----------	
Ford—Indolene Increases/Observations	1/5	0/5	5/5	
Confidence Level for Increase (%)	3.12	0.0	96.88	
All Sources Increases/Observation	9/28	5/28	15/28	3/5
Confidence Level for Increase (%)	2.64	0.02	57.18	50.00
Three-Way Catalysts—Vehicle Source:				
ARCO Unleaded Increases/Observations	1/3	0/3	3/3	
Confidence Level for Increase (%)	12.50	0	87.50	
Ford—Indolene Increases/Observations	2/2	2/2	1/2	
Confidence Level for Increase (%)	75.00	75.00	25.00	
All Sources Increases/Observations	3/5	2/5	4/5	
Confidence Level for Increase (%)	50.00	18.75	81.25	
Oxidation and Three-Way Catalysts—Vehicle Source:				
All Sources Increases/Observation	12/33	7/33	19/33	3/5
Confidence Level for Increase (%)	5.24	0.33	73.92	50.00

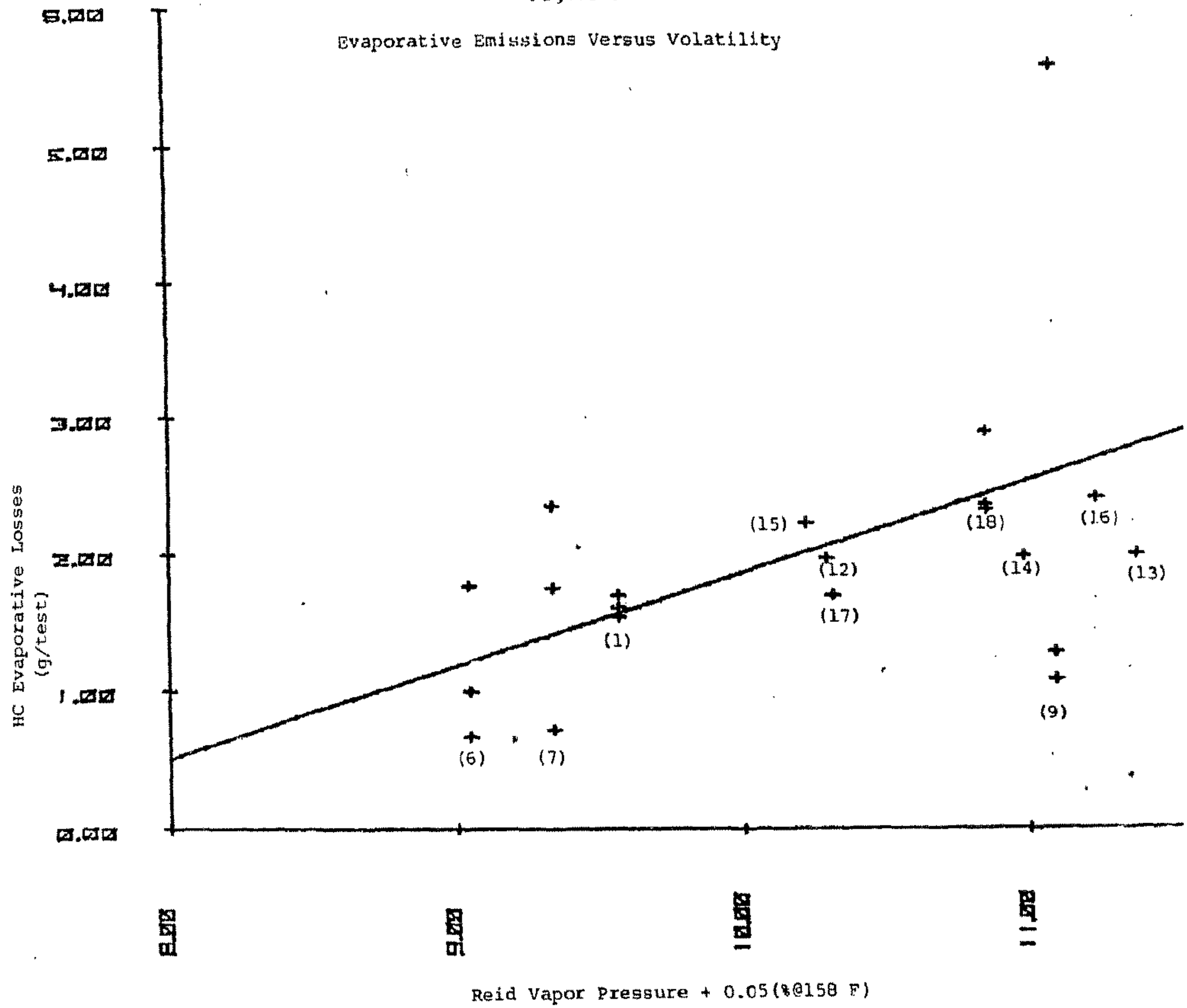
TABLE 4.—*Deteriorated Emission Comparison With Standards* (# *Failures/Total #*)

	HC	CO	NO_x
7% TBA (all sources):			
Oxidation Catalyst	0/28	0/28	0/28
Three-Way Catalyst	2/4	0/4	0/4
Oxidation and Three-Way Catalyst	2/32	0/32	0/32

[6560-01-C]

Figure 1

Evaporative Emissions Versus Volatility



AVERAGE EMISSIONS BY VEHICLE BY FUEL APPENDIX I PAGE

SOURCE	VEH	FUEL	N OBS		HC			CO			NOX			EVAP	
				MEAN	VAR	STDEV	MEAN	VAR	STDEV	MEAN	VAR	STDEV	MEAN	VAR	STDEV
F	0001	1	4	0. 9	0.003	0.05	3.84	0.59	0.77	1.34	0.029	0.17	3.40	0.884	0.94
F	0001	2	2	0.45	0.001	0.04	3.83	0.911	0.95	1.48	0.014	0.11	-	-	-
F	0003	1	6	0.85	0.054	0.23	4.38	2.455	1.57	1.77	0.095	0.31	1.71	0.180	0.42
F	0003	2	2	0.60	0.000	0.02	2.86	0.001	0.04	1.97	0.007	0.08	-	-	-
F	0004	1	7	0.40	0.005	0.07	3.47	1.816	1.35	1.18	0.004	0.07	3.98	9.548	3.09
F	0004	2	2	0.32	0.000	0.01	2.44	0.076	0.28	1.27	0.006	0.08	-	-	-
F	0007	1	3	0.80	0.012	0.11	4.96	3.968	1.99	1.40	0.000	0.02	1.62	-	-
F	0007	2	2	0.60	0.000	0.02	3.02	0.000	0.01	1.40	0.001	0.04	-	-	-
F	0008	1	3	0.41	0.018	0.14	9.04	7.421	2.72	2.29	0.073	0.27	2.49	-	-
F	0008	2	2	0.61	0.000	0.01	4.16	0.014	0.12	2.49	0.000	0.00	-	-	-
A	PIN1	3	3	0.53	0.007	0.08	2.74	1.691	1.30	1.11	0.060	0.25	-	-	-
A	PIN1	5	2	0.53	0.000	0.02	2.01	0.541	0.74	1.22	0.021	0.15	-	-	-
A	1PPA	1	1	0.46	-	-	9.35	-	-	2.66	-	-	-	-	-
A	1PPA	3	4	0.62	0.006	0.08	12.27	5.038	2.24	2.81	0.111	0.33	-	-	-
A	1MPA	5	2	0.58	0.001	0.02	12.46	2.500	1.58	3.17	0.007	0.09	-	-	-
A	MUS1	3	1	0.30	-	-	22.16	-	-	1.37	-	-	-	-	-
A	FUS1	4	1	0.20	-	-	2.01	-	-	1.21	-	-	-	-	-
A	FUS1	5	1	0.26	-	-	1.97	-	-	0.78	-	-	-	-	-
A	MUS1	3	2	0.47	0.006	0.08	4.86	0.001	0.02	2.00	0.202	0.45	-	-	-
A	MUS1	5	2	0.48	0.001	0.04	4.59	0.526	0.73	2.00	0.052	0.23	-	-	-
A	MUIC	3	4	0.77	0.010	0.10	13.89	33.992	5.83	2.08	0.087	0.30	-	-	-
A	MUIC	5	5	0.85	0.013	0.12	13.95	15.352	3.92	2.65	0.132	0.36	-	-	-
A	MAL1	6	2	0.59	0.010	0.10	7.73	2.977	1.73	1.68	0.106	0.33	0.66	0.011	0.11
A	MAL1	7	3	0.49	0.005	0.07	6.38	2.798	1.67	1.24	0.005	0.07	0.72	0.003	0.06
A	MAL1	8	3	0.45	0.008	0.09	7.99	1.692	1.30	1.18	0.218	0.47	2.62	0.981	0.99
A	MAL1	9	2	0.47	0.000	0.01	8.09	0.845	0.92	1.4	0.013	0.11	1.28	0.211	0.46
A	MAL2	6	1	1.38	-	-	26.06	15.345	3.92	1.17	0.014	0.12	0.99	0.004	0.06
A	MAL2	7	2	1.12	0.061	0.25	16.48	5.808	2.42	1.18	0.013	0.11	1.75	0.312	0.56

AVERAGE EMISSIONS BY VEHICLE BY FUEL — APPENDIX I — PAGE 2

A	MAL2	4	2	1.30	0.011	0.11	34.30	64.412	0.03	0.93	0.002	0.04	2.94	0.002	0.04
A	MAL2	4	2	1.00	0.010	0.10	22.19	0.911	0.95	1.17	0.001	0.03	1.09	0.001	0.03
A	MARN	4	1	2.13	-	-	15.18	-	-	0.90	-	-	-	-	-
A	MARU	5	1	1.52	-	-	11.55	-	-	1.17	-	-	-	-	-
A	COUG	4	2	0.67	0.001	0.03	10.41	17.464	4.18	1.62	0.045	0.21	-	-	-
A	COUG	5	1	0.52	-	-	4.89	-	-	1.67	-	-	-	-	-
A	SAFA	4	1	3.94	-	-	55.28	-	-	3.27	-	-	-	-	-
A	SAFA	5	1	3.00	-	-	48.48	-	-	2.78	-	-	-	-	-
A	CUTL	4	1	0.55	-	-	5.60	-	-	1.65	-	-	-	-	-
A	CUTL	5	2	0.69	0.029	0.17	6.94	4.263	2.06	1.73	0.083	0.29	-	-	-
A	FUTU	4	1	0.45	-	-	14.48	-	-	1.07	-	-	-	-	-
A	FUTU	5	1	0.96	-	-	7.47	-	-	1.26	-	-	-	-	-
A	SKYL	4	2	1.33	0.035	0.19	20.97	0.145	0.38	1.96	0.064	0.25	-	-	-
A	SKYL	5	1	0.85	-	-	6.77	-	-	1.63	-	-	-	-	-
A	FAIR	6	2	0.75	0.005	0.06	12.70	0.051	0.23	0.92	0.005	0.07	1.77	0.078	0.28
A	FAIR	7	2	0.84	0.001	0.04	11.04	0.186	0.43	0.94	0.001	0.04	2.36	0.088	0.30
A	FAIR	8	3	1.06	0.029	0.17	21.42	56.498	7.52	1.02	0.017	0.13	5.32	0.987	0.99
A	FAIR	9	1	1.09	-	-	12.47	-	-	1.10	-	-	5.61	0.266	0.52
T	ZEP1	10	1	0.44	-	-	5.36	-	-	1.50	-	-	-	-	-
T	ZEP1	11	1	0.46	-	-	5.65	-	-	1.04	-	-	-	-	-
T	CUTL	10	1	0.81	-	-	4.00	-	-	2.21	-	-	-	-	-
T	CUTL	11	1	0.75	-	-	5.36	-	-	1.80	-	-	-	-	-
T	FIRE	10	1	0.78	-	-	8.53	-	-	2.19	-	-	-	-	-
T	FIRE	11	1	1.01	-	-	7.30	-	-	1.88	-	-	-	-	-
T	BUIC	10	1	0.49	-	-	5.20	-	-	3.01	-	-	-	-	-
T	BUIC	11	1	0.61	-	-	5.12	-	-	2.41	-	-	-	-	-
T	FAIR	10	1	0.99	-	-	4.33	-	-	1.72	-	-	-	-	-
T	FAIR	11	1	0.56	-	-	3.49	-	-	1.58	-	-	-	-	-
T	ZEP2	10	1	0.43	-	-	1.90	-	-	1.40	-	-	-	-	-
T	ZEP2	11	1	0.60	-	-	1.86	-	-	1.51	-	-	-	-	-

AVERAGE EMISSIONS BY VEHICLE BY FUEL APPENDIX 1 PAGE 3

T	IMPA	10	1	0.52	-	-	5.17	-	-	1.32	-	-	-	-	-
T	IMPA	11	1	0.41	-	-	5.37	-	-	1.20	-	-	-	-	-
T	THUN	10	1	0.57	-	-	6.00	-	-	2.30	-	-	-	-	-
T	THUN	11	1	0.47	-	-	3.83	-	-	2.30	-	-	-	-	-
M	FAIR	12	2	0.84	0.014	0.12	6.13	0.088	0.50	1.75	0.002	0.05	1.97	0.361	0.60
M	FAIR	13	2	0.58	-	-	5.61	0.002	0.05	1.81	0.005	0.07	2.00	0.004	0.06
M	IMPR	14	2	1.13	0.020	0.14	13.65	6.090	2.47	1.65	0.001	0.04	2.24	0.072	0.27
M	IMPR	15	2	0.93	0.001	0.03	10.15	0.141	0.37	1.59	0.000	0.01	2.42	0.378	0.62
F	0002	1	4	0.29	0.002	0.08	2.47	0.268	0.52	0.92	0.001	0.05	0.93	-	-
F	0002	2	2	0.35	0.022	0.15	4.16	13.364	3.66	0.94	0.010	0.10	-	-	-
F	0006	1	4	0.26	0.009	0.09	0.68	0.012	0.11	0.59	0.001	0.04	-	-	-
F	0006	2	2	0.45	0.004	0.06	0.87	0.130	0.36	0.59	0.004	0.06	-	-	-
A	VOLV	4	1	0.25	-	-	4.83	-	-	0.12	-	-	-	-	-
A	VOLV	5	1	0.29	-	-	4.14	-	-	0.16	-	-	-	-	-
A	PINB	1	1	0.19	-	-	4.39	-	-	1.40	-	-	-	-	-
A	PINB	3	4	0.31	0.080	0.02	6.02	0.316	0.56	1.30	0.024	0.17	-	-	-
A	PINB	5	2	0.30	0.003	0.06	5.60	2.067	1.44	1.42	0.002	0.05	-	-	-
A	SUNB	1	1	0.33	-	-	7.63	-	-	0.92	-	-	-	-	-
A	SUNB	4	4	0.38	0.000	0.02	6.71	1.276	1.13	0.94	0.008	0.09	-	-	-
A	SUNB	5	2	0.35	0.000	0.00	6.57	0.001	0.03	0.97	0.005	0.07	-	-	-

FUEL CODES FOR AVERAGE EMISSIONS DATA APPENDIX 1 PAGE #

1 INDOLENE

2 INDOLENE + 7% TBA (MIXED)

3 ARCO UNLEADED

4 ARCO UNLEADED + 5% TBA (BLENDED)

5 ARCO UNLEADED + 7% TBA (BLENDED)

6 ARCO LOW VOLATILITY UNLEADED

7 ARCO LOW VOLATILITY UNLEADED + 7% TBA (BLENDED)

8 ARCO HIGH VOLATILITY UNLEADED

9 ARCO HIGH VOLATILITY UNLEADED + 7% TBA (BLENDED)

10 TEXACO UNLEADED

11 TEXACO UNLEADED + 7% TBA (BLENDED)

12 MOBIL UNLEADED A

13 MOBIL UNLEADED A + 7% TBA (BLENDED)

14 MOBIL UNLEADED B

15 MOBIL UNLEADED B + 7% TBA (BLENDED)

16 MOBIL UNLEADED A ADJUSTED + 7% TBA (BLENDED)

17 MOBIL UNLEADED B ADJUSTED + 7% TBA (BLENDED)

18 ARCO MEDIUM RANGE VOLATILITY

[6560-01-M]

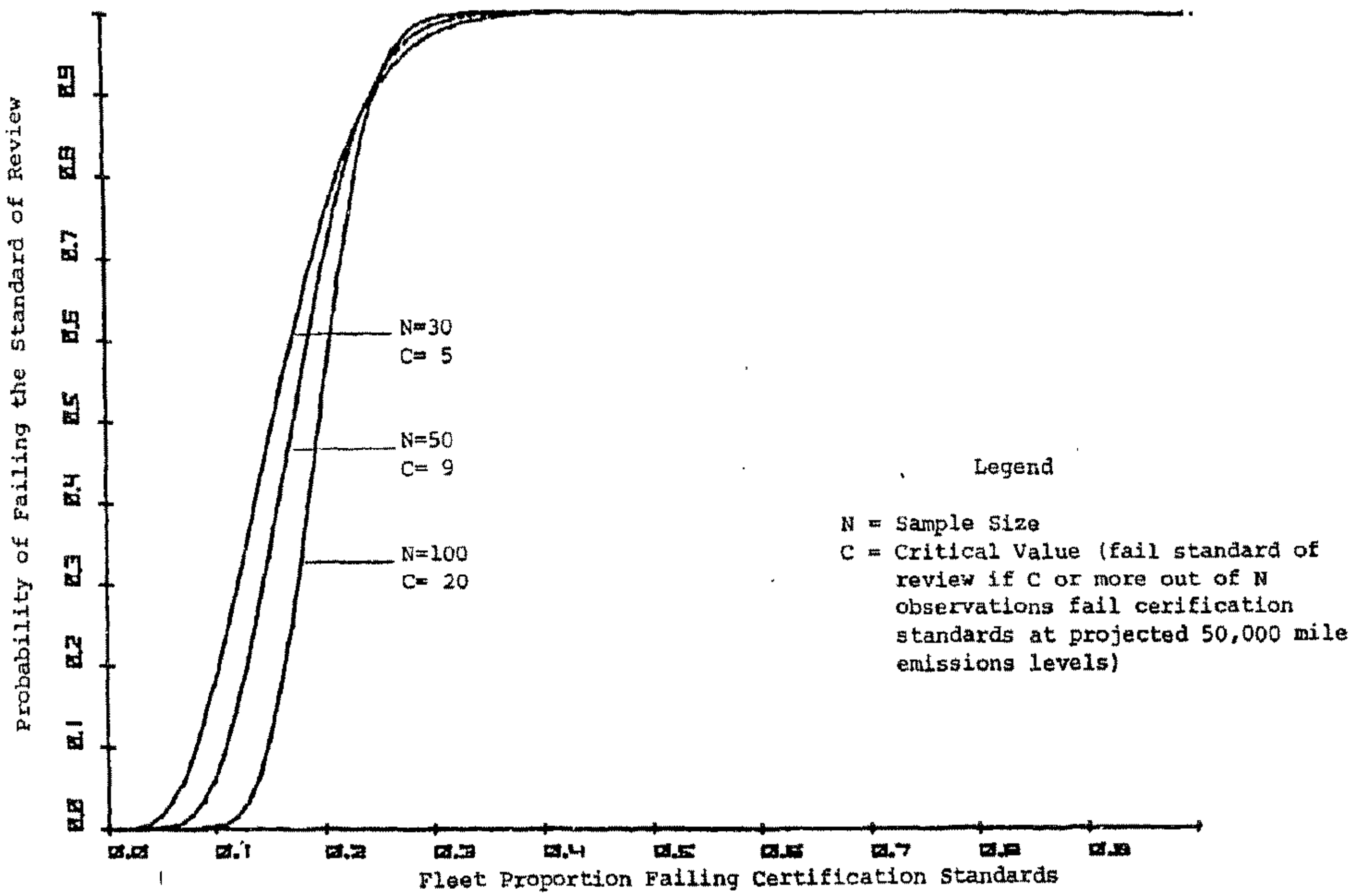
APPENDIX 2.—*Power of Binomial Test* with $p=.25$*

Sample size	*Critical value*	*Power*
10	1	.944
11	1	.958
12	1	.968
13	1	.976
14	2	.899
15	2	.920
16	2	.937
17	2	.950
18	2	.961
19	3	.889
20	3	.909
21	3	.925
22	3	.939
23	3	.951
24	4	.885
25	4	.904
26	4	.920
27	4	.933
28	4	.945
29	5	.885
30	5	.902
31	5	.917
32	5	.930
33	5	.941
34	6	.886
35	6	.902
40	7	.904
45	8	.906
50	9	.908
60	11	.914
70	13	.920
80	15	.926
90	18	.890
100	20	.900

*For purposes of analysis, this test was designed such that the risk of being denied a waiver would be at least 90% if 25% or more of the represented fleet fails to meet emission standards. This approach is related to the approach applied to the vehicle manufacturers under the vehicle assembly line selective enforcement audit procedures. While a more conservative 20% noncompliance rate has been used in some past characterization analyses, 25% is more consistent with the selective enforcement audit procedures.

[6560-01-C]

Appendix 2



Probability of Failing the Standard of Review for Different Sample Sizes and Critical Values versus the True Proportion in the Fleet Failing Certification Standards

[FR Doc. 79-5269 Filed 2-20-79; 8:45 am]